

Working with gas powered vehicles

Guidance document

When purchasing new gas powered vehicles, they are frequently maintained by the main dealer network utilising their trained staff who are specialised to their particular product. For those running their maintenance in house, options for training staff on maintaining these vehicles becomes more limited. If or when the vehicles move into the second-hand market, training options for maintenance staff become almost non-existent.

Logistics UK has been working with members to identify both training requirements and training provisions for gas powered vehicles. This guidance document highlights the risk to those who may operate and/or work on gas powered vehicles, and outlines a framework of suggested training to be undertaken to demonstrate a minimum level of competence.

Background

In regard to vehicle propulsion systems, motor vehicle apprenticeships and continuous professional development (CPD) of engineers/technicians has, over the past decades, primarily been focused on petrol and diesel internal combustion engines (ICE). Over the past few years and in fitting with the drive towards net zero emissions, there has been a trajectory towards the acquisition of vehicles powered by alternative fuels – one such source is gas.

Over the past five years the motor vehicle industry has been upskilling itself for the rise in electric vehicles and there are now a variety of technical training courses widely available for engineers/technicians to develop their competence in this area. However, what is not widely available are the same courses for gas powered vehicles, possibly due to this being a power source concentrated mainly for heavy vehicles, where vehicle volumes are substantially lower than that for cars.

Working with Logistics UK members established that beyond training offered by original equipment manufacturers (OEM) when purchasing their gas vehicles, there is little else available on the wider market. This is of concern as those vehicles are likely to go into the second-hand market in a few years and there is currently no training available to those who are not buying new vehicles. This potentially leading to a knowledge gap in the industry and hence a rise in the Health and Safety (H&S) risk for those working on such vehicles, their employers, and those in the vicinity.

What is LNG, CNG, LPG and H₂?

Liquified Natural Gas (LNG)

- Mainly methane though may contain some ethane, propane and butane.
- LNG is created by cooling natural gas to -161°C thereby creating a liquid.
- This liquid is colourless, odourless, and non-toxic, but it is an extremely cold (cryogenic) fluid.
- At ambient pressure and temperature, 1 litre of LNG will expand to 600 litres of natural gas.
- Although LNG vapours are not toxic, LNG is classified as a simple asphyxiant and as such can reduce the oxygen content of an atmosphere, especially within confined spaces.



Fig 1: LNG vehicle

Risks

- Flammability.
- Skin burns from extremely cold surfaces – cryogenics.
- Potential of asphyxiation.

Compressed Natural Gas (CNG)

- As with LNG, CNG is mainly methane though may contain some ethane, propane and butane.
- CNG is compressed natural gas at high pressures, circa 200-300 bar.
- As with LNG, CNG vapours are not toxic, however, they can reduce the oxygen content of an atmosphere, especially in confined spaces.



Fig 2: CNG vehicle

Risks

- Flammability.
- Explosion from high pressure containers.
- Potential of asphyxiation.

Liquefied Petroleum Gas (LPG)

- Mainly propane mixed with butane, traces of propylene and butylene.
- LPG is a liquefied gas byproduct derived while extracting crude petroleum.
- This liquid is colourless and odourless although refineries add odour to help with detection.
- At ambient pressure and temperature, LPG expands 250 times when changing back to vapour.
- LPG can reduce the oxygen content of an atmosphere, especially in confined spaces.

Risks

- Flammability.
- Skin burns from extremely cold surfaces.
- Potential of asphyxiation.

Hydrogen (H₂)

- Is an odourless, tasteless, colourless, and highly combustible gas.
- It is lighter than air, so rises and disperses.
- Although non-toxic, it is a simple asphyxiant and can displace oxygen, particularly in confined spaces.
- Hydrogen burns as a very pale flame with no smoke, as such it can be hard to detect fires.
- Hydrogen can be stored as either a compressed gas or as a cryogenic liquid. At ambient pressures and temperatures, one litre of cryogenic liquid hydrogen would expand to 848 litres of hydrogen gas.
- When stored as a compressed gas in pressurised cylinders or tanks, it will be stored at pressures in the region of 350–700 bar.



Fig 3: Hydrogen fuel cell vehicle

Risks

- Flammability with hard to detect fires.
- Cryogenics with potential for skin burns from extremely cold surfaces.
- Explosion from high pressure containers.
- Potential of asphyxiation.

The major differences

- LNG and CNG are the same natural gas but stored differently. LNG is cooled, CNG is compressed.
- LNG and LPG are stored as a liquid, CNG and Hydrogen are stored as a gas.
- Light pressure is used to liquefy LPG, while LNG is liquefied cryogenically, ie through exposure to extremely low temperature.
- LPG is stored, shipped and transported in tanks or cylinders, whereas LNG is stored and shipped in purpose built cryogenic tanks. Pipelines are usually used to transport LNG.
- The need for cryogenic storage, coupled with infrastructure requirements such as production plants, dispensing stations and pipeline transport facilities, means LNG is not a viable option in many developing nations.
- Should a leak occur:
 - LPG will fall to the lowest point, ie an inspection pit.
 - Hydrogen and CNG will rise to the highest point, ie a roof space in a workshop.

- LNG will fall initially, until the vapours warm, after which they become lighter than air and will rise.

Drivers and refueller training

Knowledge level

Equivalent to Electric Vehicle Awareness (Level 1), with modules that include:

- Types of gas vehicles available and their differences.
- Hazards associated with gas powered vehicle systems.
- Working safely around gas vehicles, including refuelling.
- How to isolate a gas system.

Daily walkaround checks

The usual assessment of drivers identifying fuel leaks will not apply to gas, as vapours may not be seen on the ground. Instead, leaks are likely to produce frosting and be heard and/or smelled (gas detection monitors may assist). Drivers should include a visual check of the fuel pressure gauge to ensure this is within safety tolerances (see manufacturers recommendations). Drivers should be made aware of any fuel cut-off valves fitted to the vehicle and how/when to operate them.

Refuelling

Any driver, or other person who will undertake refuelling, needs to be trained on the specifics of the fuel system used and provided with all the necessary safety equipment. In all cases before refilling, ensure that both vehicle and hose connections are clean and undamaged.



Fig 4: Refuelling of CNG vehicle

In regards to personal protective equipment (PPE), in addition to gloves and eye protection, for **LNG** and **Hydrogen**, refuelling staff should also wear PPE such as long sleeved top, long trousers and enclosed shoes, see fig 5.

Restrictions of infrastructure

There may be a restriction on the use of some road tunnels, underground areas (parking) or ferries. The company, as part of their route planning, will need to evaluate routes and destinations to identify any restrictions. Where necessary a risk assessment should be undertaken, risks controlled and then provide instructions to drivers.

Breakdown actions

The company will need to provide instructions to drivers as to what action to take should the vehicle breakdown. This should include informing the recovery/repair agent that the vehicle is of a particular fuel type, so they can send an appropriately trained person. Where fire may be involved, informing the emergency services of the fuel type.



Fig 5: Refuelling of LNG vehicle

Engineer and technician training

Undertaking of safety inspections

Knowledge level

Equivalent to Electric Vehicle Routine Maintenance (Level 2), with modules that include:

- Gas powered vehicle system components and operation.
- Hazards surrounding gas powered vehicles.
- How to reduce the risks to yourself and others when working on gas powered vehicles.
- Safely preparing the gas powered vehicles for inspections and entering workshops.
- How and where to vent systems safely.

Plus a skills assessment on how to:

- Undertake safety checks prior to preparing to inspect a gas powered vehicle.
- Undertake venting process safely.

Safety measure

Requirements for dynamic risk assessment including knowing what action to take and when.

Pre-inspection checks

Prior to a vehicle entering workshop, equivalent to a gas test on a driver walk round check.

Scope and limitations of activities

No undertaking of repair to gas system, without the necessary Level 3 training and correct facilities/tools.



Fig 6: Refuelling point notification sign

Undertaking servicing, maintenance or repair

Knowledge level

Equivalent to Electric Vehicle System Repair and Replacement (Level 3), with modules that include:

- Working safely on a gas powered vehicle.
- Using information to carry out the task.
- Carrying out repairs on gas powered systems.
- Processes for isolating and discharging gas powered vehicle systems.
- Standards to be applied for installation and pressure testing of tanks, pipes and components.
- Understanding systems and recognising defects.
- Recording information and making suitable recommendations.

Plus a skills assessment on how to:

- Isolate and discharge gas powered vehicle storage systems.
- Remove, install and check replacement tanks, pipes and components.

Safety measure

Requirements for dynamic risk assessment including knowing what action to take and when.

Scope and limitations of activities

As for 'Inspections', plus requires the necessary facilities/tools.

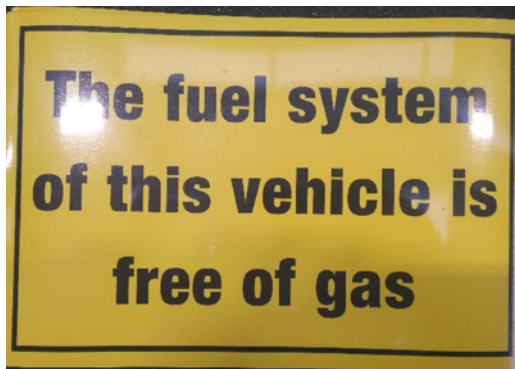


Fig 7: Purged vehicle warning sign

Undertaking body damage/repairs

Knowledge level



Fig 8: Vehicle isolated safety notice

Equivalent to at least Electric Vehicle Routine Maintenance (Level 2) – see details above, plus modules that include:

- Processes for isolating and discharging gas powered vehicles.
- Standards to be applied for installation and pressure testing of tanks, pipes and components.

Plus, a skills assessment on how to:

- Isolate and discharge gas powered vehicle storage systems.
- Remove, install and check replacement tanks, pipes and components.

Scope and limitations of activities

As for 'inspections' and/or 'servicing/maintenance/repairs'.

Undertaking vehicle breakdowns and recovery

Knowledge level

Equivalent to Electric Vehicle Hazard Management (Level 2), with modules that include:

- Those in Level 1.
- Plus knowledge required to work safely around gas vehicles.

Safety measure

Requirements for dynamic risk assessment including knowing what action to take and when.

Scope and limitations of activities

No undertaking of repair to gas system, without the necessary Level 3 training and correct facilities/tools.

Workshop provisions

Under 'The Management of Health and Safety at Work Regulations', it's a legal requirement to undertake risk assessments. As these vehicles present a different risk to that of ICE vehicles, then you need to consider the suitability of your current risk assessments for these types of vehicles.

Regulations that should be given some consideration are:

- *Dangerous Substance and Explosive Atmosphere Regulations 2002* (DSEAR).
- *Control of Major Accident Hazards Regulations 2015* (COMAH).

It is imperative that a competent person undertakes a risk assessment on the activities that may/will be undertaken in/around the workshop facilities. Any risk assessment must include a DSEAR assessment (which must be reviewed at least every five years). The risk assessment should include (this is not an exhaustive list):

- Fire precautions/evacuation notices, warning signs, equipment, etc.
- Requirements for gas detectors, both for the building and personnel.
- Lighting and ventilation, detection, alarms.
- Requirements for venting, when it's necessary, and where these should be done, and by whom.
- Tool/equipment requirements/usage, Ex marked equipment should be used where necessary.
- PPE requirements and their usage.
- Working practices that can be undertaken in and around the vehicle.
- Working at height if applicable, for example for roof mounted storage tanks.
- Warning signs and safety notices that need to be displayed in and around the vehicle.

Where companies do not feel competent to do DSEAR assessments, there are organisations available to help such as:

Inspire International UK Ltd

Email: Jagjeet@inspireh-sge.com

Phone: 0330 175 5656/07900 993922.

Web: www.inspirehsge.com

Source: <https://www.petro-online.com/news/analytical-instrumentation/11/breaking-news/whats-the-difference-between-lpg-and-lng/50495>

Annex

CNG fuel, or compressed natural gas, is the gaseous product of petroleum and is the first product that is separated during the distillation process.

CNG is odourless, tasteless and non-toxic, and is made up of 93.05% methane, nitrogen, carbon dioxide, propane and traces of ethane. It is an environmentally clean alternative fuel, as its combustion process emits a lower percentage of greenhouse gases when compared to other fuels.

While CNG fuel won't give you the same amount of power that would come from diesel fuel, it certainly has its advantages. CNG has a high-octane rating that provides a high compression ratio and is adaptable to modern engines. The combustion of CNG produces less carbon monoxide, hydrocarbons and oxides of nitrogen.

Overall, this type of gas can help in reducing pollution, as it is a clean burning fuel.

LNG fuel, or liquefied natural gas, is a natural gas converted to liquid form through liquefaction. During this process, natural gas is cooled at low temperatures until it turns into a liquid non-pressurised material that's safe, easy and cost effective to transport and store. The volume of gas is reduced by approximately 600 times in comparison to natural gas making it a space efficient alternative.

LNG is comprised of 95% methane, and other components include nitrogen, ethane, carbon dioxide and propane. It is colourless, odourless and non-toxic, resulting in less pollution and earning it eco-friendly credentials.

It's also non-corrosive, making it the fuel of choice for operating sensitive and expensive equipment and machinery.

LPG fuel, or liquefied petroleum gas, is a liquefied gas and a byproduct derived while extracting crude petroleum. It is readily available and often supplied in bottles either being referred to as propane (red bottles) or butane (blue bottles).

In the wake of new technologies and techniques, LPG is also being increasingly produced from renewable sources. LPG is considered an affordable, clean, energy efficient and portable fuel.

It weighs twice as much as air and is colourless, odourless (in its raw state, but refineries will add odour to help with detection) and is a highly flammable explosive gas. It is comprised of propane mixed with butane, traces of propylene and butylene.

One of the advantages of LPG is that it emits less hydrocarbons, carbon monoxide and oxides of nitrogen making it popular in applications operating indoors such as material handling equipment and heating appliances. It also has a high-octane rating and increases engine longevity.

The fuel weight-to-mileage of LPG is equal to that of ICE vehicles. If LPG leaks and is no longer under pressure it will change back to a vapour and frosting will appear, this will cause burning to any naked skin it comes into contact with.

Significant quantities should not be vented to atmosphere at any one time, as it is heavier than air and will creep and collect in low points such as pits, drains, etc, and will not disperse unless there is a strong wind or an extraction system to mix it with the atmosphere.

LPG expands 250 times when changing back to vapour, so small amounts of liquid make a lot of vapour.

Further information

Guidance on the *Road Vehicles (Construction and Use) Regulations 1986 (C&U)* for LPG vehicles can be found here:

[LPG \(liquefied petroleum gas\) vehicles – GOV.UK \(www.gov.uk\)](http://www.gov.uk)